RESEARCH SUMMARY

CRUISE FR 08/93

Sailed Townsville 2205 Friday 5 November 1993
Arrived Sydney 0735 Wednesday 1 December 1993

Principal Investigators

Dr Denis Mackey
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INORGANIC AND ORGANIC CARBON CYCLES IN EQUATORIAL WATERS - JGOFS

CRUISE SUMMARY
R. V. FRANKLIN
FR 08/93

PROJECT

Inorganic and Organic Carbon Cycles in Equatorial Waters - JGOFS

SCIENTIFIC PROGRAM

CRUISE OBJECTIVES

1) To measure vertical and horizontal profiles of pH, carbon dioxide and fluorescence in waters of the western equatorial Pacific Ocean.

   Underway measurements were made of in situ fluorescence and pH. A comparison of measured pCO2 and calculated (from pH and alkalinity) pCO2, done on FR05/92, showed good agreement. The most significant source of error was due to drift in the pH electrodes. This effect was reduced during FR08/93 by using a new flow cell with two pH electrodes in series. The system worked well and all the data was successfully logged by the new software. Very low in situ fluorescence was observed and the new hardware and software resulted in a different relationship between the output from the Turner fluorometer and the DELP numbers.

   Vertical profiles of pH were not measured but samples were collected for the analysis of Alkalinity and dissolved inorganic carbon (DIC) back in Hobart. Vertical profiles of in situ fluorescence were obtained using a SeaTech fluorometer(s) connected to the CTD. The fluorometer(s) will be calibrated from measurements of extracted Chl a determined by HPLC. Preliminary data, using the calibration from FR05/92, suggest that the concentration of Chl a is much more variable than on previous cruises with maximum values of about 0.8 μg l-1, compared with 0.5 μg l-1 for FR05/92. Repeated sampling at a given location showed the depth of the chlorophyll maximum moved by up to 25 m in 4 hours. This movement was due to vertical movement of isopycnals rather than to migration of the phytoplankton.

2) To study the primary and secondary productivity of these waters.

The photosynthetic parameters of primary production was measured using a small-bottle, 14C incubation technique at 6 depths at 17 sites during the northward transect along 1550E. In addition, 5 sites were resampled on the southward leg. A total of 240 production vs light intensity curves were recorded. At the 6 process stations primary production estimates were made on water samples taken at approximately midnight, 0800, 1200 and 1630 hrs. Only a single depth profile of primary production was made at the remaining stations. On the southward leg, 5 depths were sampled, allowing one depth to be replicated at each site. Three process stations and the island wake enrichment study were abandoned due to time restrictions caused by the change of arrival ports from Townsville to Sydney to enable the bow thruster to be fixed.

Secondary production was not measured. Zooplankton biomass estimates in the upper 100 m were made using a 0.25 m2 mouth area, 200 micron mesh aperture, free-fall zooplankton net.

3) To study the physical, chemical and biological processes that determine the vertical fluxes of carbon across the air-sea interface and within the water column.

The vertical flux of carbon out of the euphotic zone was measured at the 6 process sites by deploying free-floating sediment traps for approximately 24 hours at each site. Modified Knauer traps were suspended at depths of 150 and 500 m, and 8 samples were collected from each depth. Samples for dissolved organic nitrogen and phosphorus estimates, were taken at each process station to 200 m, and detailed profiles to 300 m were made at 20N, 10N, and at the equator on the southward leg. Phytoplankton samples, and samples for flow cytometry (to determine prochlorophyte, cyanobacteria, and bacterial abundance) were taken at selected depths at selected sites.

The levels of Pb210 and Po210 will be determined in the dissolved and particulate phases and Ra226 will also be determined in the dissolved phase. From these parameters, collected at 100S, 50S, 0, 50N and 100N, the sinking rates of particles from the upper water column in this region will be determined.

4) To study the chemical, physical and biological processes leading to increased biomass along the equator at the western boundary of the Pacific Ocean.

The island wake enrichment experiment was cancelled because of time restrictions. This did not allow us to assess the potential for increasing primary production downstream of the island caused by mixing and uplift of nutrients into the euphotic zone due to current flows.

Samples were collected for the analysis of wide suite of biological, chemical and physical properties. Preliminary data from this cruise have indicated that there is considerable variability over periods of ranging from hours (24 hour stations on FR08/93) to weeks (FR07/90 and FR08/90, Legs 1 and 2 on FR05/92, and repeat stations on FR08/93) to years (FR08/90, FR05/92 and FR08/93). A full analysis of the data from the three cruises, in conjunction with an analysis of data collected by other participants in the Equatorial JGOFS program should greatly improve our understanding of the carbon cycle in the western Equatorial Pacific.

5) To use chemical methods, such as lipid and pigment analyses, for characterisation of the phytoplankton community structure within different water masses.

No samples were collected for the analysis of lipids. Samples were collected for the analysis of chlorophylls and carotenoid pigments by HPLC. A new software package, developed at DO, will be used to assess the phytoplankton species composition from the concentrations of these pigments. We are particularly interested in obtaining information on the variations in pigment composition in a given species as a function of external parameters such as depth (light intensity).

CRUISE NARRATIVE

This cruise was be based on two transects along 155^0E and a number of 24-hour time series measurements that were made at 5^0S, 3^0S, 0, 3^0N, 5^0N, 8^0N on the northbound transect and at 20N, 10N, 0 and 30S on the southbound transect. At each of the time series stations, we deployed drifting Knauer sediment traps with eight samples collected at depths of 150 and 500 metres.

In general casts were made to 2000 m and 300 m at each location. At many locations, additional casts were made for the collection of trace metals, naturally occurring radionucleides etc.

After leaving Townsville on the evening of Friday November 5th, the laboratories were a hive of activity as we set up our equipment and started calibrating the fluorometers, underway pH sensors etc. The first stop was at 13^0 48'S, 151^0 36'E where we checked the Niskin bottles for leakage and had a test run of all our sampling procedures to ensure that we had not been too ambitious in our plans for sampling everything we could think of out of 10 litres of seawater. All went well and demonstrated that the considerable time and effort that had gone into developing our sampling was well worthwhile.

After our first official station at 10^0S we proceeded northwards but had to move our next station from 8^0S to 7^0 12'S as we did not receive permission to sample in the territorial waters of the Solomon Islands. A further submission to the Solomon Islands to sample at 8^0S on the return transect received no reply. The station planned at 5^0S was shifted to 4^0 5^0'S to minimise the chances of the sediment traps drifting within the exclusion zone around Buka Island.

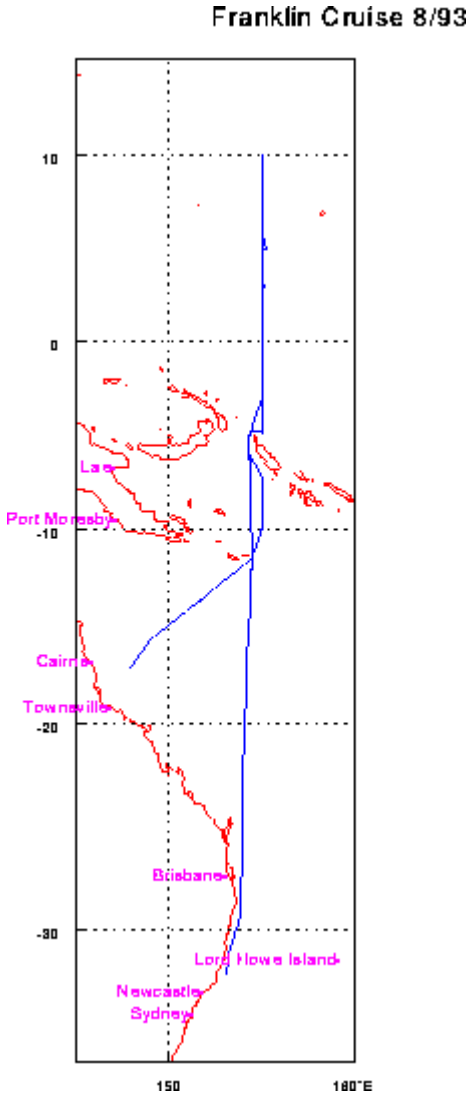
As we moved northwards, the tradewinds gradually subsided, seas were slight but the weather was dull and overcast. At 3^0N, there was a westerly wind burst with 25 kt winds (gusting to 30 kt) over a period of about 6 hours. We passed within a few miles of Nukuoro Island and confirmed our observations from FR05/92 that (i) it is approximately 2 nm away from the position marked on Japanese charts of 1937 and, (ii) the northeast corner looks a great place to surf.

At this stage disaster struck and the bowthruster went on leave. We had the most impressive wire angle at 3^0N that I had seen on a hydrocast since the old days on Diamantina. Fortunately, for the rest of the cruise, conditions were kind enough that the lack of a bowthruster did not compromise the program. The only effect on our routine was that the master was reluctant to recover the sediment traps at night.

From the equator to 6^0S on the return transect, we had good conditions with mirror flat seas and winds 'gusting' to 2 knots. The sunsets were superb! As we moved southwards into the Coral Sea, conditions derteriorated markedly and from about 10^0S to 15^0S we were battling into rather lumpy seas.

Following numerous Faxes, it was decided that it would be necessary to go into dry dock to repair the bowthruster. At this stage we did not know where we would finish, whether we would have sufficient fuel to get there, or whether we would have to make a sharp right turn and head to Gladstone for fuel. In the final event, the cruise finished in Sydney rather than Townsville and, the research program was modified slightly so that we had sufficent fuel with the cruise being extended by only 15 hours.

CRUISE TRACK



PERSONNEL

Ship's Crew		Scientific Staff
Master	Neil Cheshire	Denis Mackey (DO) - Chief Scientist
Mate	Dick Dougal	Brian Griffiths (DF)
2nd Mate	Ian Menzies	Harry Higgins (DO)
Chief Eng.	John Scott	Jeanette O'Sullivan (DO)
2nd Eng.	Peter Harding	Ros Watson (DO)
Elec. Eng.	Don Roberts	Pru Bonham (DF)
Bosun	Jannik Hansen	Sandy Garland (DF)
AB	Bluey Hughes	Bob Griffiths (ORV) - Hydrology
AB	Kris Hallen	Les Drury (ORV) - Hydrology
AB	Andy Russo	Bob Beattie (ORV) - Computing
Greaser	Tony Bernadin	Erik Madsen (ORV) - Electronics
Steward	Reg Purcell	Philip Towler (U. Melb.)
Chief Cook	Gary Hall	
2nd Cook	Bob Clayton	

[PB]

Appendix A

Natural Radionucleides - FR08/93 (Philip Towler)

Measurement of naturally occurring radionuclides as tracers of particle flux from the upper layers of the ocean.

Profiles were collected at 10^0S, 5^0S, 0, 5^0N, and 10^0N along the 155^0E transect. Each profile consisted of six samples of 40 L each taken at depths down to 300 m. Each sample was filtered using a 142 mm diameter membrane filter with a pore size of 0.45 μm. The filter was held in a Sea Star filter holder. Initially the filtration was attempted using a vacuum manifold. This method was extremely slow so the filtration was done under pressure. The four Niskin bottles of each sample were pressurised and the water from all of them directed through a single filter.

Only one of the filter holders contained a filter support of plastic mesh. Using this filter support allowed the 40 L of seawater to be filtered in approximately 50 minutes. Various other materials were tried as filter supports in the second filter holder with a course cotton mesh finally being settled on. The filtration took twice as long with the cotton filter support compared to the plastic mesh.

The filters were stored for analysis in Melbourne. The radionuclides of interest were concentrated from the filtrate and the bulk of the water discarded. The "concentrates" will be analysed in Melbourne.

The levels of Pb210 and Po210 will be determined in the dissolved and particulate phases. In the dissolved phase Ra226 will also be determined. From these parameters the sinking rates of particles from the upper water column in this region will be determined.

Appendix B

Wet Laboratory Report - FR08/93 (Harry Higgins)

At each of the stations, samples were taken from the surface to 2000 m with most of the biological sampling centred around the chlorophyll maximum (typically 85 m but spanning the range 65 - 100 m). A 5 m depth resolution typically between 55 and 100 m was chosen to adequately sample the nutracline.

In addition to the standard DO, salinity and nutrient samples the following samples were taken :

Pigments	272	158 to be processed initially (3 of the 4 casts at the process stations to be archived)
Bacteria	177	
Flow cytometry	177	
Phytoplankton	104	Profile at 1230 cast of process stations and

		DCM at other stations (52 samples were air-dried and 52 were preserved with glutaraldehyde)
NH4	330	
DIC	121	At 10, 5, 3 and 1S, the equator and 1, 3, 5, 8 and 10N.
DOC	97	
DON/DOP	107	

Apart from the DO, salinity, nutrient and some of the NH4 samples (which were analysed on board) the rest of the samples will be returned to Hobart on the Franklin for processing in Hobart and thus no preliminary results are available. Isotope casts, trace metal casts and productivity results are discussed in seperate reports.

The new compressed air pressure filtration system was more efficient and safer than the previous 240 V vacuum system. The portable fan mounted in the wet lab made working conditions more pleasant in this otherwise hot and humid area.

On several occaisions Milli-Q and distilled water ran out in the chemistry and wet labs. Distilled water from the ships supply in the engine room had to be manually carried in carbouys to the header tank 2 decks up. This was an unsatisfactory arrangement, particularly in rough weather. A better pumping or distilled water supply system should be investigated urgently.

Appendix C

Biology - FR08/93 (Sandy Garland)

DON/DOP Profiles

DON/DOP samples were collected at each process station on the first transect at 0, 25, 50, 60, 70, 80, 125 and 200 m. Dissolved nutrients profiles were also taken from 20N, 10N, 0, 20S and 30S. Depths sampled at these stations were 0, 25, 50, 60, 70, 80, 90, 100, 125, 150, 200, 250 and 300 m. In all 98 samples were collected and transferred frozen to Hobart laboratories by domestic flight as excess baggage. In the Hobart laboratories they will be analysed by FIA for nitrite, nitrate, phosphate, total phosphate and total nitrate.

Size Fractionation Experiment

In addition 20 DON/DOP samples were collected for a size fractionation experiment from the second equatorial station (CTD 73) and at an additional station at 4^0 12'S (CTD 78). Each sample was filtered through acid washed millipore filters ranging from 0.1 to 1.2 æm. These are to be analysed by FIA for nutrients as above.

Sediment Traps

Sediment traps consisting of 2 x 8 traps lowered to 140 and 800 m were deployed at 5^0S, 3^0S, 0, 3^0N, 50N and 8^0N. The traps were filled with high density salt solution. Prior to and on retrieval of the traps, samples were taken for DON, DOP and DOC. Four of the traps from each depth were filtered through 3 pre-combusted, pre-weighed GF/F filters (2 singles and 1 double) for CHN analysis on return to the Hobart laboratories. Of the remaining traps, at each depth, sediment samples were collected for pigment analysis, SEM and 15N/13C analysis. In all 12 single and 6 double filters were collected for CHN analysis, 12 filters for SEM and 12 filters for 15N/13C analyses. All were frozen for their return to Hobart by domestic flight. The 12 pigment samples were immersed in liquid nitrogen and are to remain on the Franklin until she arrives in Hobart.

UV Absorption Experiment

On the second transect at 2^0N, 1^0N, 0, 2^0S and 3^0S samples were collected close to the chlorophyll maximum. These are to be analysed for pigments by a UV absorption on filter technique. In addition to filtering 2 litres of each niskin through a 2.5 cm GF/F filter, normal 4.7 cm and 8 4.7 cm pigment samples were collected and remain in liquid nitrogen on board the Franklin.

POC/PON Precision Experiment

At 4^0 12'S a special cast was made (CTD 78) to collect 10 niskins of sea water from the chlorophyll maximum (96 m) for a POC/PON precision experiment. Each niskin was filtered through pre-weighed, pre-combusted filters for CHN analysis in the Hobart laboratories. The 10 samples were frozen and returned to Hobart via domestic flight.

Appendix B

Hydrology - FR08/93 (Bob Griffiths and Les Drury)

Summary

5 November - 1 December 1993

Townsville - Sydney
78 CTD stations were completed.
OMS samples were taken from 44 of these.
Analyses carried out:

Salinity: 575

Dissolved Oxygen: 825

NO3, NO2, PO4 & Si: 825

Low Range Nitrate: 290

Auto analyser

Standard ranges run for nutrients:

Nitrate: 0 - 35 μmol l-1

Silicate: 0 - 140 μmol l-1

Phosphate: 0 - 3.0 μmol l-1

Nitrite: 0 - 1.0 μmol l-1

Low Range Nitrate: 0 - 7.0μmol l-1

The NO2 manifold was rebuilt. All pump tubes were replaced. The flow circuits of the system were checked and modified as the sample and buffer lines on the existing NO3 channel had been swapped. Standards were made but these had to be discarded as the NaCl (batches B3 and B2), used for the matrix LNSW, contain significant levels of NO2. The NO3 and particularly the NO2 baselines were consequently elevated compared to the PW baseline. Fortunately uncontaminated, pre-weighed NaCl was "borrowed" from stocks used in the sediment trap work. The NO2 standard on board VL 24/1/91 was found to be about 10% lower than the new standard 11/93 sent from Hobart. It was noticed that some of the nutrient tubes are warped and need careful orientation in the carousel to avoid the probe sampling the air next to the tube. Once up and running, apart from a source globe burning out, (amazingly between runs), the system ran faultlessly.

Salinity

Salinometer 74 has an intermittent problem with the μA meter sticking. The short term solution was to tap the meter before each reading. High temperatures

in the lab caused some problems with narrow temperature compensation ranges. The salinometers have unguarded 240 V connections in the vicinity of the operators wet hands. An appropriate portable earth leakage protection device needs to be installed between the mains and the instrument as a matter of safety.

Sampling

The voyage plan specified OMS to assist with OMS bottle sampling where possible. OMS assisted with, and supervised the collection of OMS samples except during some periods of intensive laboratory work. An additional nutrient tube was taken (triplicate), to provide for low level nitrate determination, from each depth from the surface to 70 metres.

Chemicals

A container labelled as KI (for DO) contained insoluble white pellets, not KI.

Computing

The Datamini computer has some sort of memory conflict, when hard booted it will hang at 'pcnfs installed'. This problem was side stepped during the cruise by hard booting with modified config.sys and autoexec.bat files followed by a soft boot with the normal configuration files. The new version of DAPA (4.1) was installed at the beginning of the cruise but had to be removed as it would kick you out when processing data. The old version of DAPA worked for channels A, B & C but had a corruption during printing of about 50% of the channel D runs for nitrite, the corruption was also in the Lotus files produced for this data.

Water Sampling Bottles

10 litre bottles were rigged for the 24 bottle rosette. Testing to the salinity minimum at station 1 revealed no contamination of any bottle. During pressure filtration, several bottles leaked from the cone joints and the end plug handles. Sykaflex was used to seal the leaks. Bottle 10/14 was lost and 10/2 was repaired when the push rod broke. Inspection showed the s/s pins had expanded with corrosion cracking the rod. This may explain other bottles which have come away from the rosette on this and other voyages. To make use of the Niskin log the bottles need to be permanently numbered. We marked the ten litre niskins 10/# and recorded any problems or repairs in the Niskin logbook.

Water Distillation

Due to the high purity of the feed water the still produced a low yield. The

water from the VAP was carried to the MQ header by hand as the pump from the VAP could not lift water to the MQ header (the engineers have been asked to look into this during the next port call). The millistack filters blocked up and were replaced. The new filters also blocked within a day and the 4 MQ cartridges were replaced. The replacement kit had different cartridges: A-milligard (short), B-carbon, C and D-ionex.

Things to do: Permanent and exclusive ID for each Niskin.
Provide effective pump VAP to MQ header tank.
Determine correct nitrite standard and apply corrections if required.
Get DOS 6 onto Datamini and rectify memory conflicts.
Investigate DAPA problems.

Things to order: 2 MQ cartridge kits with extra millistack (if no new MQ ordered)
1 ammeter to suit salinometer (Master Inst. M86).
Sodium chloride suitable for LNSW
Portable earth leakage protector.

Appendix C

Ammonia - FR08/93 (Ros Watson)

The aim was to test run the ammonia determination at sea. The technique uses gas diffusion with a reaction of ammonia with o-phthaldialdehyde to produce a fluorescent derivative.

Samples processed

Approximately 330 samples were collected, in duplicate acid-washed tubes, from selected depths around the flourescence maximum. Of these, 140 samples have been analysed by the completion of the cruise with the remaining samples frozen for analysis back at the marine labs in Hobart. The samples analysed to date include all of the midnight and noon casts from each of the process stations.

Problems encountered

Initial problems encountered were: low sensitivity, the occurrence of negative peaks and slow elution times. It was thought that these problems may have been associated with blockages in the fine bore tubing surrounding the detector and/or membrane fatigue resulting from the high back pressure. This was eventually overcome, however the back pressure on the detector waste was

reduced compared to that used in Hobart.

A new diffusion cell had been made by the workshop and was to be tested on the cruise. Initial tests suggested that the reagent channels may have been too shallow and too wide, although there were pressure problems in the detector line occurring at the same time. Time did not permit further testing.

The citrate used in the alkaline donor line was found to be high in ammonia, as this was known to be a possibility an inline acid wash was being used, but was found not to be effective. It was thought that this may be due to a lower porosity of the tubing used compared to published data in similar systems. To try and overcome this the workshop made diffusion cell was put inline of the citrate/NaOH solution with 10% HCl continuously flowing on the other side of the membrane. This reduced the ammonia contamination and it is hoped that any remaining contamination can be corrected for. This problem will still require investigation back at the marine labs.

It would appear that for some of the samples analysed that some CTD cast data may show greater variation between duplicate readings compared to other casts. This will be further investigated with analysis and the processing of more samples.

Initial results and future directions

Initial results appear promising with greater reproducibility and thus sensitivity compared to results obtained back at the marine labs, with some cast data showing less than 5 nM variation between duplicate samples. It is possible that this is due to the cleaner ammonia-free environment of the clean container compared to the general lab environment. It is hoped that the FIA equipment can be set up in either the semi-clean room or the clean container at the labs to try and over come any contamination problems.

It is hoped that when the contaminations problems (ie citrate and lab environment) are solved or contained (I'm an optimist) and the method runs reasonably smoothly that I can look into what would be required for optimum storage and sample handling requirements.

Appendix D

Computing - FR08/93 (Bob Beattie)

My duties for this voyage were primarily the support & further development of the new data acquisition software.

Jeff Dunn installed updates to the manager, shared-memory system, user interface and ADCP logging. Most of the first week of the voyage was spent correcting minor problems with these and other data-logging programs.

We still have a way to go in improving the ease of management & the user friendliness of the system. However, it is proving to be very reliable.

User interface, shared memory etc.

The user interface performed almost flawlessly once I'd installed Roger's patch to the manager.

Roger's new usleep is much more robust than the previous version. But we still experience 'hang-ups' if delp is monitoring tri. (tri updates at 0.5 Hz & each delp updates at 1 Hz.). We never seem to have problems if delp is not monitoring tri.

ui problems & suggestions

1. ui data window should only display data that is younger than the device update time.

2. If the ui window is overlaid with another window, which is then removed, its contents are not restored until the mouse has been 'clicked' inside it.

3. On several occasions, the user interface would display a '?' whenever the cursor was placed over a menu item, and the menu item could not be selected.

Archiving

The daily tape archives should continue more or less in their present form, but the mechanism for copying to the archive area needs to be given more thought.

It can take 3 or 4 days for a file to be copied into the archive, which defeats the purpose of having an area where users can get timely access to the data.

The following strategy may be more appropriate:

1. Selected new files to be copied from newdata to a single archive directory (with or without subdirectories for the individual data types). (The files could be 'copied' as links to save disk space.)

2. The copying would be done once per hour & would not usually include files of raw data.

3. Once per day, the archived underway data for the previous day would be concatenated into instrument day files.

4. A manually initiated job would be run, after each day's tape archiving, to delete data files more than two days old. By this stage, the files will have been written to tape at least twice, & generally three times, on each of two computers!

For this strategy to work, the modification dates of the data files copied between cpu's would need to be set to the date of copying, rather than the date of last modification.

Tape capacities

Both archive tapes filled up towards the end of the cruise & new tapes started.

Errors were reported by cpio and dd, but daily_cpio was not notified & thought the archive sessions had completed normally. Is there any way of getting the completion status of calls to system? My reading of the documentation implies that system only reports an error if it can't launch a process.

The tapes overflowed because we were recording much raw data this voyage. This will not normally be done once we are satisfied that the averaged data is ok. None-the-less, we need to give some thought to the problem.

1. Archives should be written in Exabyte 8500 mode density, if this is not already the default mode for the 8500 drives.

2. Is there any way of increasing the block size above that specified by the cpio -B option?

cpu usage & disk i/o

All logging & display was done on fdcs-user.

cpu usage on fdcs-user was normally around 15-20%. The main cpu hogs are fsflush, smm, tri and the sundry delp's.

The hourly data file copying was a significant load until a problem in the script was corrected. These backups now take approx 30 secs, vs 20- 40 mins previously.

Suggestions

1. If cpu usage is high, and there is no obvious culprit, it may be worthwhile rebooting the offending cpu.

2. The data acquisition processes do a fflush after each write. This puts quite a load on the system, especially if raw data is being acquired. It would be better if the fflush's were removed and for the system to be requested to do a disk sync every 10 secs (say)

3. Processes reading shared memory should use the combined 'get update time & value' form of request, rather than the separate 'status' & 'value' calls.

Miscellaneous suggestions, comments & problems

1. Log level should be used to control the logging, or otherwise, of raw data.

2. The 'move-to-archive' procedure needs to be more automated, as the present manual commands are potentially very dangerous. eg if the '-type f' option is omitted from the find, the directories will be moved, trashing the existing archive sub-directories!?

3. It is too difficult to get the x-terminals' xdm to be on the correct cpu if they are logged out of, or rebooted, for any reason. In fact, it is nigh on impossible if the logging software is active.

4. ctdmain should be terminated with 'q', rather than 'exit'. 'exit' is rather dangerous, as it also means 'exit from the current shell'.

5. ctd_main needs protection from over-length keyboard input. If a long record is entered, eg when a key is accidentally held down, & <return> is hit, ctd_main crashes with a seg fault.

6. The ctd logging program needs an audible alarm when bottles are fired, especially the 5 min samples.

7. The Turner/DataTaker logging needs to be made more versatile. eg at times, we may wish to log strain gauges or thermometers etc. This could best be achieved through the use of a configuration file, as per the met station.

8. start_system occasionally exits.

9. How does a process reading from or writing to sms, know that smm has been stopped & re-started.

10. Where possible, the data analysis & display programs should use stdin & stdout for input and output and stderr for operator messages, so that they can be combined to perform more complex tasks.

    This will not be practical in some cases, eg where programs produce NCAR plots. In these cases, Error messages should go to stderr and operator prompts to stdout. If this is done, the input parameters can be read from a pipe or redirected file and the prompts redirected to /dev/null.It can be tedious entering the parameters for the user programs. This could be reduced if each program had a commented, editiable configuration file. This could be passed through a filter program, to remove the comments, & piped to the display program. eg

    comment_filter < opt_file | ctdsect > /dev/null

11. All logging & display programs should be converted to use 4-digit year numbers, vs the present 2 digits, as I sincerely hope our logging system will still be around by the year 2000! (It would also make the dates consistent with Unix usage.)

12. Manual, as opposed to automatic, operation of rcs does have some pitfalls. eg if a programmer forgets to 'check in' a file, no one else can check it in or out. ie there is no record of who made any subsequent changes to the file.

13. We need a small case to carry the Exabyte tapes around the ship. There is too much risk of them being dropped when they are loose.

Other work done includes:

1. The requested patches for ctd_set, & the_manager were installed.

2. Scripts were written to simplify the weekly backups and to copy the ctd .cro files to the hydro account. The latter was set up as a twice-daily cron job.

3. Tidying up and minor corrections and additions to most of the 'generic' input controllers. including:

    - The Turner data is now scaled according to the range setting.

    - Eliminated the cause of frequent record length errors in the gpt logging.

- The pH programs accept records with or without a temperature temperature channel and can now handle negative readings correctly.

4. Checked and corrected hash_check_vars, device_list & the device database. Hopefully there now aren't too many undocumented sms variables!

5. Wrote scripts & programs for concatenating the hourly underway files into day files and for merging the underway sea data. The concatenation software could form the basis of a revised 'new-to-archive' system.

6. Ran some adcp tests for Jeff Dunn, using various settings of the fish detection parameter. The data looked ok with settings of 25 & above, but was increasingly degraded as the setting was reduced below this level.

7. Checked the Turner calibrations for the present and original logging systems.

Appendix E

Clean Container - FR08/93 (Jeanette O'Sullivan)

When the clean container was inspected in Townsville a few problems were found.

The window had leaked on the port side with water marks on the bench and floor.

Rust was found on the inside at the rear safety door.

The rear door could not be open and had to be opened with a crow bar.

A couple of racking positions were still a tight fit for the niskins.

The leak in the window was sealed with silicon sealant.

The fibreglass on the step of the rear door was ground so the door would shut and vaseline was placed around the seals. Leakage from the container could still be felt at three of the four corners of the door. Also water poured in when we had heavy rain. Because the air was at a positive pressure the leaks were not plugged.

It was also noted the during the voyage that the pressure within the container was not up to the usual specifications. The lab pressure was ÷ 35 pascals and the airlock pressure was ÷ 18 pascal. The gaps found in the rear door were sealed, but no improvement was seen. The engineers increased the pressure by removing a piece of the primary filter which was very dirty. I asked them to put the filter back when it when I was sampling. They could not remove the grid to clean the filter and the screws in the grid had corroded.

The drawers within the container seem to have deteriorated over the years and a large amount of wood particles are falling into the drawers and resulting in a possible contamination source.

A couple of screw in the ceiling vents were corroding. These were covered with sealant.

The filters above the laminar flow were cleaned with detergent 0.1% Triton X -100 and tap water. They were shaken dry, left to drain and then replaced.

The plastic cover above the clean room entrance had extra gaffer tape put on before leaving Townsville. This seemed to hold throughout the cruise with no leaks appearing.

The NH_4 determinations seem to be successful in the clean container environment.

Maintenance of the Clean Container

1. The step of the rear door will need replacing and the rust removed and seals to be fixed.

2. The drawers within the container need to be looked at to prevent the wood particles falling out.

3. The rear intake grid needs to be modified so it can be removed easily and screws replaced with non corroding metal.

4. Replace the primary filter

5. Check pressures after seals have been fixed and the primary filter replaced.

6. The 3 marked racking positions in the air lock to be made wider.

7. Check screws and metal areas for corrosion. Treat the rust and coat with 'special' paint or sealant.

8. The plastic coated chain in the air lock should be replaced.

Trace Metals

11 Helmond Byrne niskins were used in sampling.

Five niskins (86, 87, 88, 89, 90) with the old set up and nylon strings were put at depths 200, 250, 500, 1000, 1500 metres.

Five niskins (85, 95, 96, 98, 99) with the old set up and kevlar strings were put at depths 0, 50, 100, 150, 2000 metres.

One niskin (94) with new end caps and nylon strings was placed at a replicate depth of 1500 metres.

At 5S (ctd# 9) and the equator (ctd# 24), 10 samples were collected including the duplicate depth at 1500m. The 2000m bottle did not fire therefore only 9 depths were sampled.

At 5N (ctd# 54) all bottles fired and 11 samples were collected from 10 depths.

Each niskin was sampled for

1. Trace metals (TM)
2. Free copper (pCu)
3. Copper complexation (CuCC)

An additional survey was done where a replicate productivity sample was collected from a TM bottle. This was done at the repeat stations 2N, 1N, 0, 2S, 3S (ctd# 69, 71, 73, 74, 77)

One TM sample was taken from 2N @95m. Two TM samples were taken from the 1N @70m, one from the TM niskin and one from the normal GO niskin @70m. For the other casts ctd# 73, 75, 77 a replicate productivity sample was collected from the TM niskin in the entrance to the clean container.

Helmond Byrne Bottles

The new end cap design sampled well with no leakages and without losing an 'O' ring. The 'O' ring needed to be reseated before going in the water but went well afterwards. This new design did not improve pressure filtration and still leaked.

Both the kevlar strings and the nylon strings did not stretch and seemed to sample the same. For the pressure test there was no consistency in the results relating to the type of strings used. I feel the rubber supports are the weak

link in the system.

The new set up with the 0.22 μm filter in the bleed valve when sampling seemed to work well with the sampling.

The final results on the success of the new designs will not be known until the samples are analysed. The sampling shows no significant improvement with the kevlar strings and the results should indicate any possible contamination from the woven thread.

Underway System, pH and Turner Fluorometer

pH

Two electrodes were run on line and logged on the DELP
pH 1- 9.3122
pH 2- 9.430

The temperature sensor had to be replaced at the start of the voyage. After the temperature sensor was replaced the system ran very smoothly. Calibrations were run every 2 days.

A spare temperature sensor should be put on board and a spare pulse dampener.

Turner Fluorometer

Problems were found reproducing previous Delp readings relative to the Turner. A lot of negative figures were logged with the Turner reading 0 and negative readings.

Bob put in a multiplying factor so the output on the DELP for a given Turner value was the same on whatever scale was been logged.

The values of the surface waters were very low throughout the cruise. The calibration rod was consistent and calibrations were run every 4 days.

A problem which requires attention is when the Turner is calibrated the high output of the fluorometer when the cell is open shuts down the logging. A note has been placed on the Turner to shut done the logging and turn off the data taker BEFORE calibrating.

SeaTech Calibration

The SeaTech was calibrated throughout the CTD stations. The regular calibration detected small changes in the output on two occasions and an increase in the blank/background reading on another. The detection enabled early correction of

the problems and therefore consistency between stations. The other calibrations confirmed a stable output of the particular instrument. A difference was seen in the calibration and blank of the two instruments used SN 74 and SN 97. Filtered seawater blanks were also measured and showed a different response from the two different sites tested.

DIC/Alkalinities

Samples were collected from standard casts at 10S, 1S, 1N, 10N. Samples were also collected at the midnight cast for the productivity stations at 5S, 3S, 0, 3N, 5N and 8N.

10 depths were sampled at each site, 0, 25, 3 productivity depths, 125, 200, 300, 500, 700, 1250 and 2000 metres.

Wet Laboratory Sampling

The wet lab becomes very hot in the tropics and would benefit from a fan installed on the wall. A fan was borrowed and placed above the milli Q system and it definitely provided some relief.

Appendix G

Electronics Report - FR08/93 (Erik Madsen)

This report deals mainly with instruments that required maintenance or service during the cruise, other equipment may be considered to have operated satisfactorily.

Preliminary work

Ctd #1 was fitted in the large 24 Bottle frame with Fluorometer # 74S, battery pack and Light sensor # UWQ 4059.

The new Ops Room air condition controller that was installed prior to leaving Townsville enabled rack temperature to be controlled to within 1 0C, and about 4 0C below a comfortable room temperature, thus eliminating the condensation problem experienced on FR07/93.

Cabling for RS232, Appletalk and Ethernet to the Chief Scientist cabin was completed.

A considerable amount of sand blasting grit was removed from the thermo salinograph sensor tank when the sensors were cleaned.

CTD System

A repetitive step function that was proportional to pressure in magnitude in the real time oxygen plot caused the sensor to be replaced 8/11/93, but as the condition persisted, the Oxygen I/F card and complete sensor assembly were replaced with those from ctd#2.

It was noted that the wiring harness on the oxygen sensor receptacles in both ctd's were very brittle at the potting junction, the one from ctd#2 broke on dismantling and required substantial machining to gain access to the solder cups.

A large offset and slope error (0.168 - 0.095) is evident in salinity values from ctd#1 during a 2000m cast.

The bigctd plotting routine prefixes light values above 1000 mE with (%) both on scale lines and in data values, as this did not cause errors in the plotted values, no corrective measures were taken.

Licor Light Sensor Units

To obtain uniform and real values (mE) from the light sensor packages, the feedback resistors in each electronics package was changed to a value which corresponded to 2000mE (2000 mmol s-1 m-2) for an output of 5 volt. The respective resistor value was noted on the calibration sheet for each sensor.

XBT MK12

Some time was spent on re-wiring the hand launchers from the PC through the Led controller to remote junction box sockets, and although the hardware is now ok., there is still, despite some modifications, software problems associated with version 2.3 of this instrument.

Fluorometer

This instrument was calibrated regularly, using milli-Q and filtered sea water for blank and 25 mg/l Rhodamine for 50% span check. On Nov. 13th., a reduction in sensitivity of about 14% caused me to dismantle the instrument and inspect/clean all lenses, although no contamination was evident, an improvement in sensitivity to below -10% was achieved by this exercise.

Later in the voyage the blank check increased to 5.5%, this was remedied by cleaning connectors, although there was no visual evidence of contamination. However on Nov. 19th. a patch which looked like condensation was discovered between L2 and W1 of the transmitter lens ensemble. As these components are

permanently fixed, the only option was to replace the fluorometer with #97.

Trimble GPS

On switch on, and after considerable time setting time, this instrument produced velocities of around 200 Kn. in north westerly direction and around 80 Kn. downwards for some hours until a very close reference position was entered, it was 190 00'S, 1490 00'E and had to be reset to 190 00'S, 1460 30'E.

Although up to ten satellites were often visible, the Trimble would hang on to one which was only 6 - 7 degrees above horizon irrespective of the 100 elevation mask.

To achieve good position data for the ADCP, it was necessary to manually de-select satellites at regular intervals.

RDI ADCP

A design flaw in the break maker circuit caused some initial problems. The schematics specified a 2.7M ohm resistor for R3, whereas the Board overlay only specified a 270K ohm and as the board was loaded from the overlay, the break from a Sun work station was to short to be recognised as such.

Erratic graphics display of velocities was experienced from time to time as GPS quality was reduced.

Computers and Printers

On Nov. 16 it was necessary to re-boot fdcs-user to free a hung user interface, unfortunately, in order to get the X-terminals back onto fdcs-user, it seems necessary to temporary kill fdcs-log1 and fdcs-log2 and then re-boot them after the X-terminals have successfully booted from fdcs-user, this process needs further looking at.

A floppy drive fault in the Toshiba 1000 causing read errors rendered this PC unserviceable for a while, but it came good on own accord after a few days.

The Cable Sys Compaq Portable ll suffered from a hard disk failure on power up, it was remedied by manually manipulating the head stepping motor.

As this 8Mhz PC is about 8 years old, only has a 20M hard disk and a single 360K floppy drive, I suggest that it be replaced with the GP lab PC when this is upgraded in the near future.

Meteorology Station

This instrument performed well until about 01:00z 27/11 when the wind direction stuck on about 480, however, as inclement weather at the time prevented any remedy being implemented, wind speed and direction were invalid from then to 01:30z 29/11, when weather state allowed me to affect repairs. Although the sensor is now working, it is rather noisy around 270 - 330 degrees and requires a replacement potentiometer.

Thermosalinograph

On Monday Nov. 29th, I was informed that the salinity looked high (39.15 ppt), examination of the instrument revealed a difference of 4 0C. between inlet and conductivity sensor housing temperatures, according to the raw data files this difference had gradually crept up since Nov. 25th. The fault was located as contact problems in the wet laboratory conductivity sensor housing electronics package.

Data from this instrument should be scrutinised carefully and salinity re-calculated, using inlet temperature where necessary.

Ship Equipment

The 30 cm radar range switch was repaired to enable switching to ranges below 3 nm.

The Sailor watch keeping receiver antenna, which had been disconnected for some time, was re-terminated.

The Nav Trac GPS RS422 - 232 fan-out box was changed from DC to AC operation and the GPS ground tracks were separated from power and RS232 ground to remove a 24 volt earth fault indication in the bridge distribution panel.

The ship steerable cct camera was repaired, but two new overload switches are required for internal fan and heater.

The recreation room video recorder developed a bad tracking problem, this was repaired by cleaning transport mechanism and heads.

The ship office 486 PC floppy drive "A" suffered connector problems, most likely caused by vibrations, re-seating power and data cables remedied the symptoms.